Title: Record Breaking Flight

Brief Overview:

In this unit students will create model airplanes using different variables, such as model type and paper. The unit involves data analysis through the use of various tables and graphs. It also involves a language arts aspect as students will be required to write a business letter.

NCTM 2001 Principles for School Mathematics:

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2001 Standards:

- **Content Standards**

Algebra

- *Understand patterns, relations, and functions; and describe, extend, and make generalizations about geometric and numeric patterns.*
- *Use mathematical models to represent and understand quantitative relationships; and model problem situations with objects and use representations such as graphs, tables, and equations to draw conclusions.*
- *Analyze change in various contexts; and investigate how a change in one variable relates to a change in a second variable.*

Measurement

- *Understand measurable attributes of objects and the units, systems, and processes of measurement such as length, area, weight, volume, and size of angle and select the appropriate type of unit for measuring each attribute; and understand that measurements are approximations and how differences in units affect precision.*
- *Apply appropriate techniques, tools, and formulas to determine measurements; select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles; and select and use benchmarks to estimate measurements.*

Data Analysis and Probability

- *Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them; design investigations to address a question and consider how data-collection methods affect the nature of the data set; collect data using observations, surveys, and experiments; and represent data using tables and graphs such as line plots, bar graphs, and line graphs.*
- *Select and use appropriate statistical methods to analyze data; use measures of center, focusing on the median, and understand what each does and does not indicate about the data set; and compare different representations of the same data and evaluate how well each representation shows important aspects of the data.*
- *Develop and evaluate inferences and predictions that are based on data; and propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions or predictions.*

- **Process Standards**

Problem Solving

- *Instructional programs from prekindergarten through grade 12 should enable all students to apply and adapt a variety of appropriate strategies to solve problems; and to monitor and reflect on the process of mathematical problem solving.*

Reasoning and Proof

- *Instructional programs from prekindergarten through grade 12 should enable all students to recognize reasoning and proof as fundamental aspects of mathematics; make and investigate mathematical conjectures; and select and use various types of reasoning and methods of proof.*

Communication

- *Instructional programs from prekindergarten through grade 12 should enable all students to organize and consolidate their mathematical thinking through communication; communicate their mathematical thinking coherently and clearly to peers, teachers, and others; analyze and evaluate the mathematical thinking and strategies of others; and use the language of mathematics to express mathematical ideas precisely.*

Connections

- *Instructional programs from prekindergarten through grade 12 should enable all students to recognize and use connections among mathematical ideas; understand how mathematical ideas interconnect and build on one another to produce a coherent whole; and recognize and apply mathematics in contexts outside of mathematics.*

Representation

- *Instructional programs from prekindergarten through grade 12 should enable all students to create and use representations to organize, record, and communicate mathematical ideas; and select, apply, and translate among mathematical representations to solve problems.*

Grade/Level:

Grades 4-5

Duration/Length:

The unit contains three lesson plans which may last from 3-5 days.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Measuring to the nearest meter
- Creating line plots and bar graphs from a given set of data
- Interpreting mean and median from data
- Writing a business letter.

Student Outcomes:

Students will:

- read to perform a task in order to create their model airplanes.
- predict results before gathering data.
- use line plots and bar graphs to represent and describe data.
- identify the mean and median of the data they collect.
- communicate findings orally and in writing.
- utilize the scientific method to complete the experiment.
- write a business letter to share information.

Materials/Resources/Printed Materials:

- Student Resource Sheets
- Access to the Internet (optional)
- Measuring tool in meters
- Origami paper/construction paper/loose-leaf paper (depending on the model)
- Calculator (optional)

Development/Procedures:

Day 1

Motivation

1. The teacher will display pictures/models of different airplanes from different time periods. The class will discuss the different models and their characteristics, as well as how the models have changed over time. Lead students in a discussion of what characteristics might affect the flight of the planes (i.e., weight, shape, size).

Procedure

1. Propose the following vignette to the students (Student Resource #1):

Special Agent Air O. Dynamics, this is your mission. You are to be inducted into the Guinness Book of World Records for flying a paper airplane the furthest distance. First, you must decide which model airplane to use. Next, you must decide upon a material from which to construct your plane. You will be responsible for gathering and graphing all of your data.

Good luck on your mission! The Guinness Book awaits you!

2. The teacher will choose directions for three different model paper airplanes from Teacher Resource #1 for the class to construct. (Or, students may search resources and decide upon their own group model depending on the time available). The teacher will construct each model beforehand and present them to the class. Discuss the three models with the class. Ask them which plane they think will fly the furthest distance and have them explain their answers.

3. The teacher will introduce the scientific method as part of the following experiments. Review each part of the scientific method with the class. Students will begin Experiment #1 by making a hypothesis as to which paper airplane will fly the furthest (Student Resource #2).

4. Divide the class into three equal groups. Designate a model airplane to each group. Students will complete the Experiment portion of Student Resource #2. Each student will follow the directions in order to construct their group's airplane out of loose leaf paper.

5. Take students to an area conducive for flying the paper airplanes (i.e. outside--wind is a variable, gymnasium, cafeteria). Allow students to practice flying their airplanes. Then, students will fly their planes three times, record the distance of each flight to the nearest meter and find the median from these three flights. (Ėxperiment portion of Student Resource #2)

Day 2

1. Each group will gather their flight data for all three trials on a line plot (example on Teacher Resource #2). Assess the line plot according to the rubric on Teacher Resource #3. Each group will find the median of the flight trials from their line plot.

2. Each group will represent the median of their line plot on a single class bar graph (Teacher Resource #2). Based on this bar graph students will complete the Analysis and Conclusion portion of Student Resource #2. Discuss findings with the class and have students decide which model airplane they should use for their mission.

3. Now that students know which model airplane is able to fly the furthest, throw in another variable! Ask students what could affect the flight of the chosen model airplane. Introduce three types of paper (construction paper, looseleaf paper and oragami paper). Discuss the three different types of paper with the students and have them make a hypothesis as to which paper will fly the furthest (Student Resource #3).

4. Divide the class into the original three groups and designate a type of paper to each group. Students will construct the chosen model airplane using their group's designated paper. (The teacher should give either construction paper or oragami paper to the group whose model was chosen so they can construct the plane again).

5. Simulate the flight activity from yesterday. Students will complete the experiment portion of Student Resource #3.

6. Each group will gather their flight data for all three trials on a line plot (example on Teacher Resource #2). Each groups will find the mean of their flight trials from their line plot.

7. Each group will represent the median of their line plot on a single class bar graph (Teacher Resource #2). Based on this new bar graph students will complete the Analysis and Conclusion portions of Student Resource #3). Discuss findings with the class and have students decide which paper they should use for their model airplane.

Day 3

1. Now that students have chosen a model and a type of paper they will all make the model (if they have not already done so). They will fly their planes and record their distances for some last trials.

2. Students will write a business letter to The Guinness Book of World Records in order to inform them of their furthest distance when flying a paper airplane (Student Resource #4). Score this letter according to the rubric on Teacher Resource #4. When students complete a final copy of the letter they may send it to The Guinness Book of World Records!

Performance Assessment:

- Continuous assessment throughout all activities using teacher observation.
- Accuracy in completing line plots and bar graphs, and finding the mean and/or median.
- Assessment using the rubric for scoring the line plots.
- Assessment using Student Resource activity sheets.
- Assessment using the rubric for scoring the business letter.

Extension/Follow Up:

- Graph the air time for the paper airplanes. (The world record is held by Ken Blackburn at 27.6 seconds.)
- Add a variable in the experiment by modifying the weight of the airplanes by adding paper clips to the nose of the planes.

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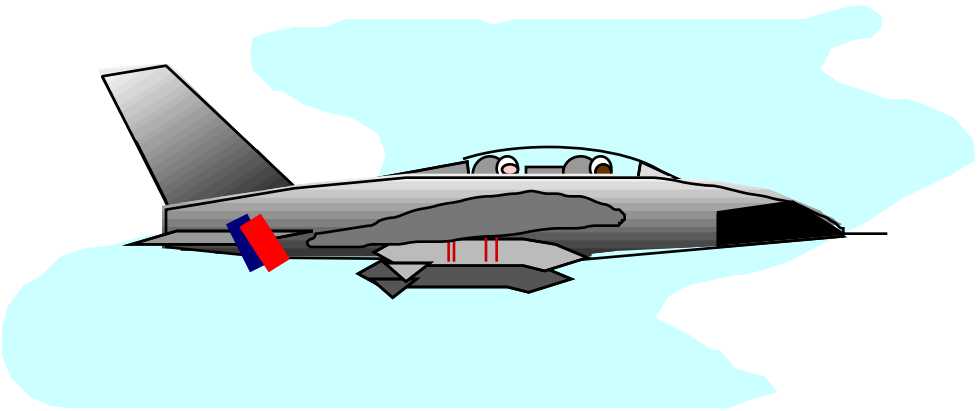

Record Breaking Flight

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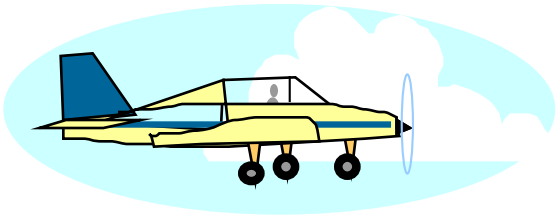
Good luck on your mission! The Guinness Book awaits you!

SOURCES FOR MODEL PAPER AIRPLANES



WEB SITES

http://www.geocities.com/CapeCanaveral/1817/

http://www.onenorthpole.com/ToyShop/Paperairplanes.html

http://www.paperairplanes.co.uk/rapier/html

http://aerogami.com

http://www.josephpalmer.com/planes/Airplane.shtml

http://www.paperairplanes.co.uk/

BOOKS

Blackburn, Ken and Jeff Lammers. Kid's Paper Airplane Book. Workman Publishing Company: December 1996.

Collins, John M. The Gliding Flight. Ten Speed Press: October 1989.

Fogleman, Floyd and Richard Kline. The Ultimate Paper Airplane. Simon & Schuster: June 1985.

Schmidt, Norman. Best Ever Paper Airplanes. Sterling Publications: August 1995.

Footman, Tim. Guinness Book of World Records. Bantam Books: New York, NY. 2001.

Experiment #1

Purpose: Does the fold of an airplane affect the distance it travels?

Hypothesis:

_____
_____

Experiment: 1. Follow the written directions to make your group's model paper airplane.

2. You will fly your paper airplane three times. Record the distance for each trial. Round to the nearest meter.

Trial	Distance
1	
2	
3	

Circle the model used.

Model 1

Model 2

Model 3

List the flight distances for all three trials in order from shortest to longest. Circle the **median** of your flight distances below.

_____meters _____meters _____meters

Share your **median** with your group. Was it close to the **medians** from their trials? Circle below:

yes no

Why do you think this happened? _____

_____

3. You and your group will now create a line plot to show your results. Fill in your flight distances on the line plot for **all three** of your trials. With your group, find the **median** of the distances on the line plot.

My group's **median** from our line plot: _____meters

4. Your group will now complete one part of a class bar graph. On this bar graph your group will be responsible for representing the median from your line plot.

Analysis: Look at the data from your class bar graph. Which model paper airplane flew the furthest distance overall? How can you tell?

_____
_____
_____

Conclusion: Did you prove or disprove your hypothesis? Explain.

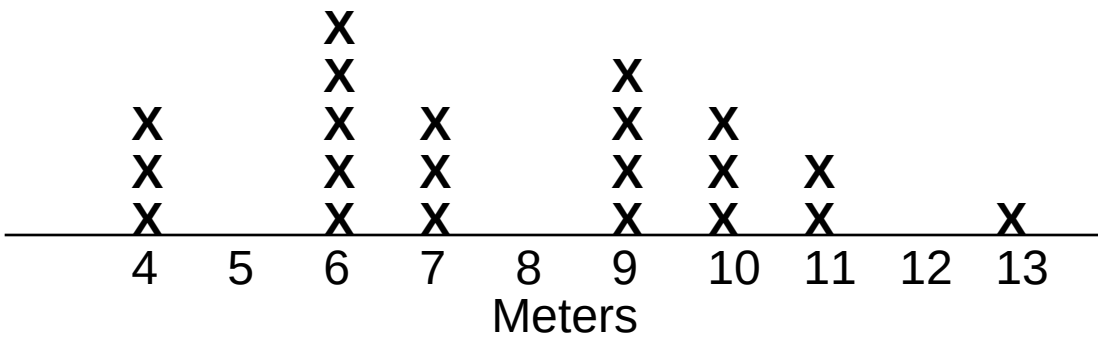
_____
_____
_____

What conclusions can you draw from your data?

_____
_____
_____

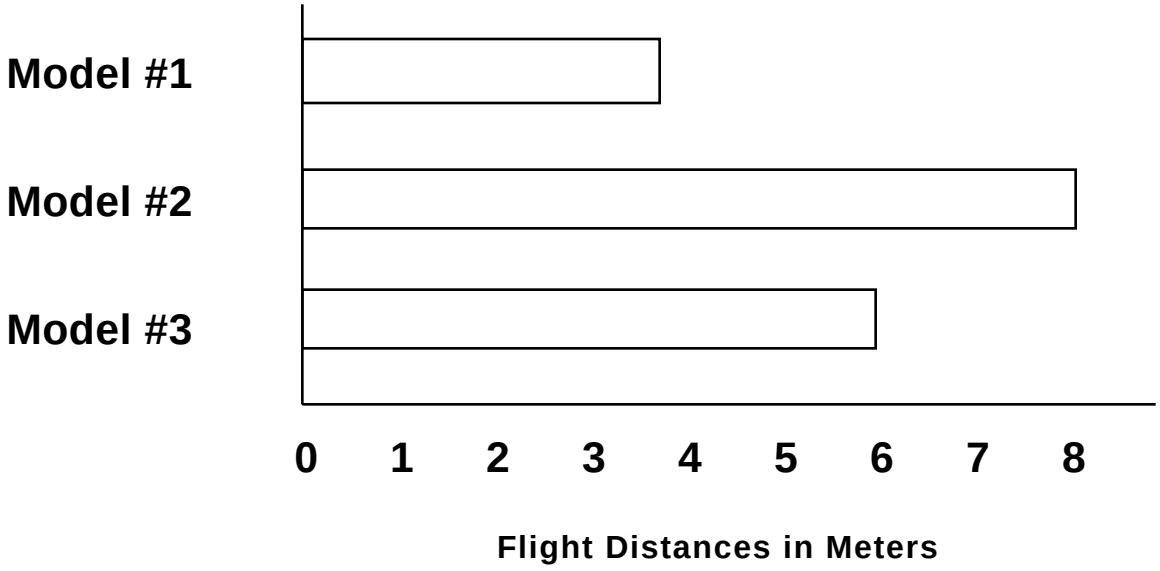
Each group will create a line plot to show the distances their model paper airplanes traveled. Each student will plot all three flight trials on the group line plot. Below you will find a sample response for one group's data.

Model #1 Flight Results



After the line plots have been constructed, the **median** from each group's line plot will be determined. The median flight distance of each model will be used to make a class bar graph. After, comparing these flight distances, the model with the farthest flight distance will be chosen for Experiment #2.

Flight Results from Airplane Models



Rubric for Line Plot

3 points	*Graph title.* *X-axis labeled.* *Appropriate range of data.* *Median is correct.*
2 points	*2 of the elements listed above.*
1 point	*1 of the elements listed above.*
0 points	*None of the elements listed above.*

Experiment #2

Purpose: Does the paper an airplane is made from affect the distance it travels?

Hypothesis:

_____

_____

Experiment: 1. Follow the written directions to make the model paper airplane using your paper.

2. You will fly your paper airplane three times. Record the distance for each trial. Round to the nearest meter.

Trial	Distance
1	
2	
3	

Circle the paper used:

Oragami paper

Loose-leaf paper

Construction paper

List the flight distances for all three trials in order from shortest to longest. Circle the **median** of your flight distances below.

_____meters _____meters _____meters

Share your **median** with your group. Was it close to the **medians** from their trials? Circle below:

yes no

Why do you think this happened? _____

_____

3. You and your group will now create a line plot to show your results. Fill in your flight distances on the line plot for **all three** of your trials. With your group, find the **median** of the distances on the line plot.

My group's **median** from our line plot: _____meters

4. Your group will now complete one part of a class bar graph. On this bar graph your group will be responsible for representing the median from your line plot.

Analysis: Look at the data from your class bar graph. What was the paper used to make the airplane that flew the furthest? How can you tell?

_____

_____

_____

Conclusion: Did you prove or disprove your hypothesis? Explain.

_____

_____

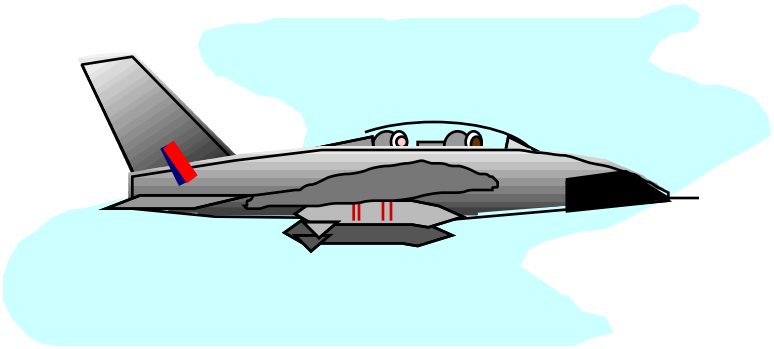
_____

What conclusions can you draw from your data?

_____

_____

_____



Congratulations! Now that you have put your best foot forward in constructing your model paper airplane it is time to enter the Guinness Book of World Records. Write a business letter to the authors of this book and explain why you think you should be inducted. Be specific and inform the authors of:

- *the purpose of your experiments*
- *the steps of your experiments*
- *the data you collected*
- *the results of your experiments*
- *the flight distance of your paper airplane*

Remember to be detailed and write your information in sequential order. GOOD LUCK!

Form _____

Audience _____

Topic _____

Purpose _____

Business Letter Format

_____
(Date)

_____
_____
_____

(Guinness Book Address)

_____
_____
_____

(Your address)

Dear Sir/Madame:

_____
_____
_____
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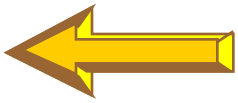
_____
_____

Sincerely,



(Sign your name in this space)

_____
(Print your name)

Rubric for Business Letter

4 points	*Correct letter format includes scientific method information (purpose, steps, data, results); includes flight distance written in sequential order.*
3 points	*Includes 3 of the items listed above.*
2 points	*Includes 2 of the items listed above.*
1 point	*Includes 1 of the items listed above.*
0 points	*Includes none of the items listed above.*